

LESSON 4 WET CONSTRUCTION METHOD

DRILLED SHAFT FOUNDATION INSPECTION

DECEMBER 2002

LESSON 4

WET SHAFT CONSTRUCTION

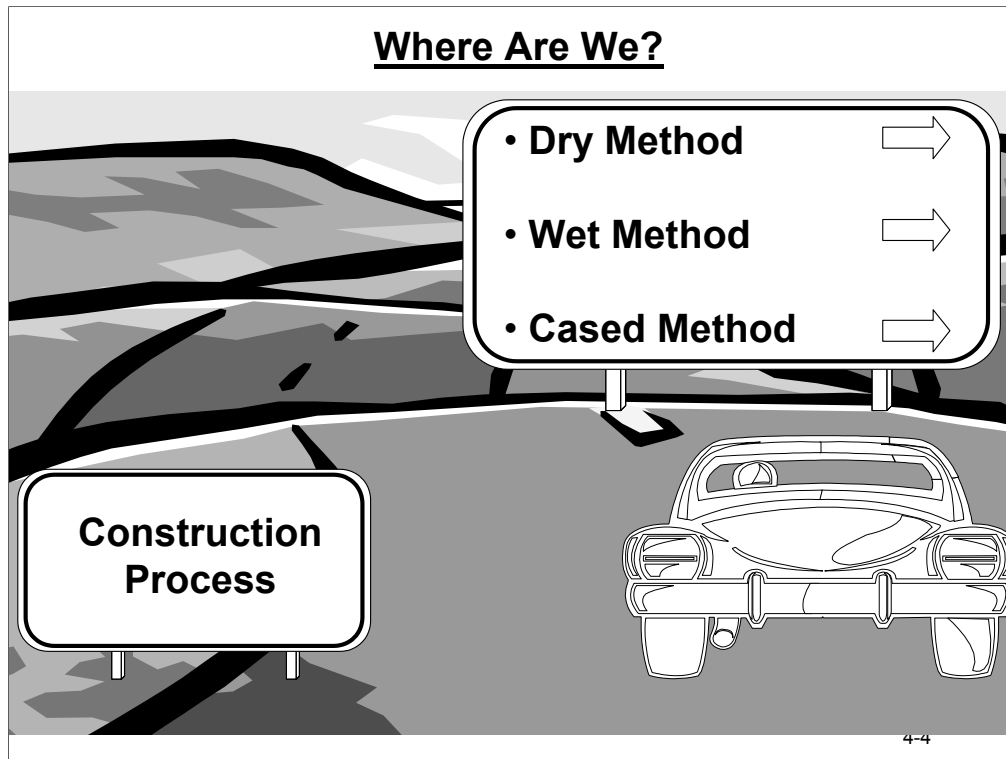
NOTES

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LESSON 4

WET SHAFT CONSTRUCTION

4-3



LEARNING OBJECTIVES

- **Recognize the difference between dry and wet shaft construction.**
- **Describe the wet shaft construction process.**
- **Describe and identify mineral and polymer slurry and other drilling fluids.**
- **Describe typical construction problems associated with wet shafts.**

4-5

WHAT IS A WET SHAFT?

Often called the “slurry-method”, wet shaft construction is when a slurry or water is used to keep the hole stable for the entire depth of the shaft.

4-6

WHEN USED?**FHWA Publication IF-99-025****xxx.32 WET CONSTRUCTION METHOD:**

The wet construction method may be used at sites where a dry excavation can not be maintained for placement of the shaft concrete. This method consists of using water or slurry (mineral or polymer) to maintain stability of the borehole perimeter while advancing the excavation to final depth, placing the reinforcing cage, and concreting the shaft.

WHEN USED

- When a dry excavation cannot be maintained; cannot manage water seepage
- When the sides and bottom of the excavation are unstable; collapsing, caving, sloughing
- When loose material cannot be properly removed; sediment, cuttings, slurry, water

WET -VS- DRY?

It is more expensive.

Requires more Contractor expertise.

Requires more equipment.

The sides of the hole will not remain stable.

Accumulated loose material & water cannot
be removed.

Has more than 12" of accumulated
water in the bottom of the shaft.

4-8

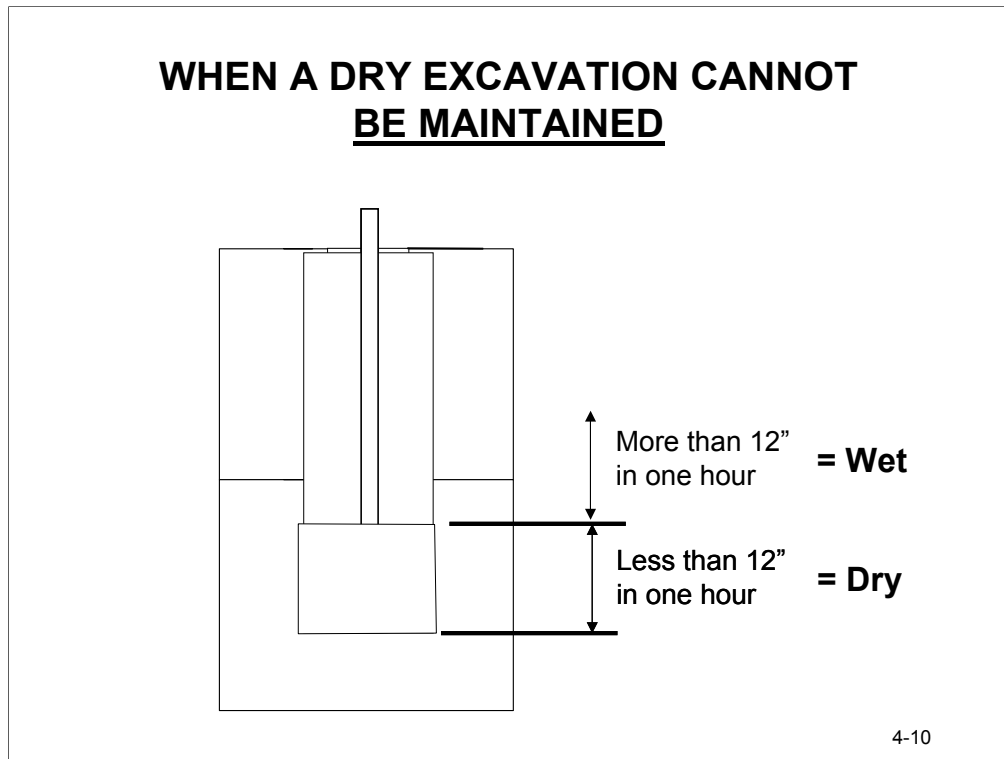
Because the dry method is the least expensive and requires the least expertise, many Contractors will push for the dry method, even when geological conditions indicate that it probably won't be successful.

The differences between the two are like night and day. A Contractor experienced at wet shafts can generally handle dry shaft construction, while the opposite is not true.

WET -VS- DRY?

The Inspector cannot visually inspect the shaft and cannot see what is happening underground



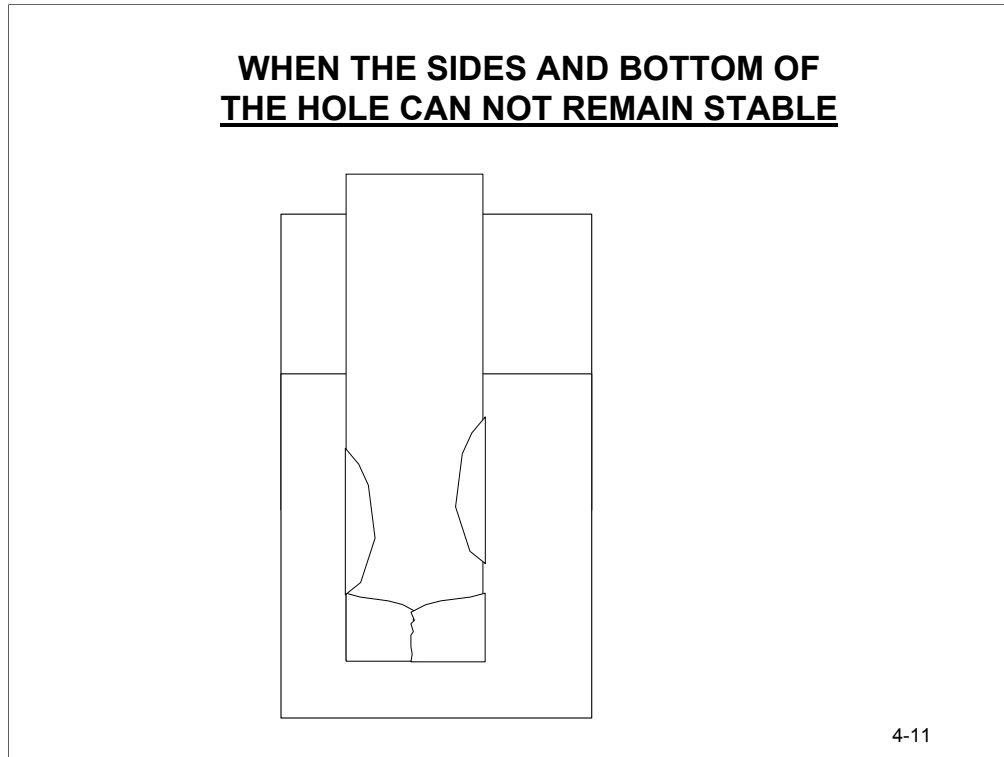


FHWA Publication IF-99-025

xxx.32 WET CONSTRUCTION METHOD:

The wet construction method may be used at sites where a dry excavation can not be maintained for placement of the shaft concrete...

The shaft is considered "wet method" if more than 12" of water accumulates in the shaft over a one hour period without pumping.



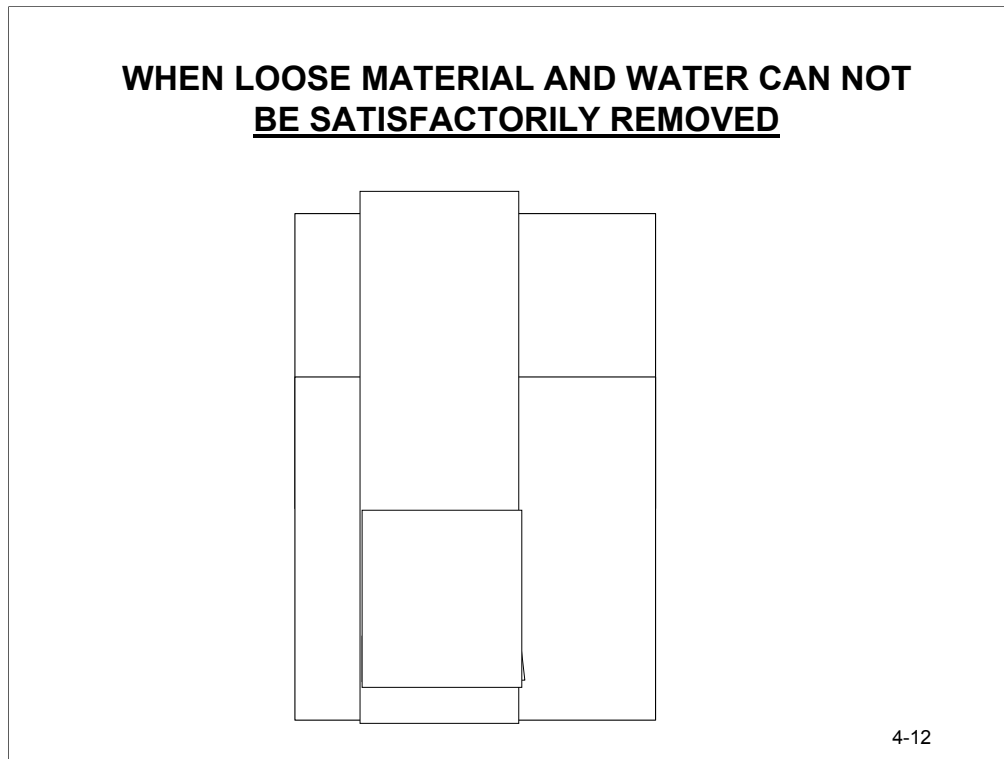
As discussed below, if the sides and bottom of the hole cannot remain stable without caving or swelling over a 4 hr period following excavation, then the dry shaft method cannot be used and either the wet or cased method is to be employed.

FHWA Publication IF-99-025

xxx.31 DRY CONSTRUCTION METHOD:

Commentary

...the sides and bottom of the hole remain stable without detrimental caving, sloughing or swelling over a four-hour period immediately following completion of excavation;...



If the loose material and accumulated cannot be satisfactorily removed prior to inspection or concrete placement, the wet or cased method is to be employed.

FHWA Publication IF-99-025

xxx.31 DRY CONSTRUCTION METHOD:

Commentary

... and any loose material and water can satisfactorily be removed prior to inspection and prior to concrete placement...

LEARNING OBJECTIVE #1

Recognize the difference between dry and wet shaft construction

What constitutes the difference between wet and dry shafts?

What is perhaps the most significant difference between dry and wet construction to the Inspector?

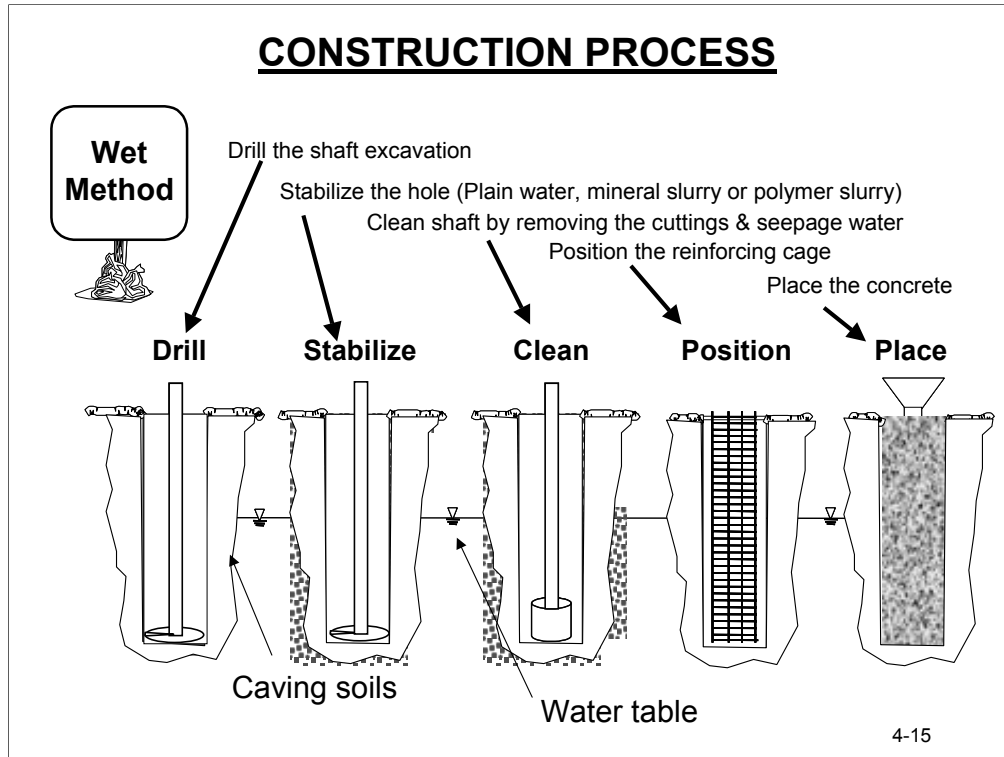
4-13

LEARNING OBJECTIVE #1

Recognize the difference between dry and wet shaft construction

Why do Contractors, in general, try to avoid wet shaft construction?

4-14



Unlike the dry construction method, in this situation the water table may be above the shaft tip elevation or the geology consists of unstable or “caving” soils. Think of trying to dig a hole at the beach or lake near the water’s edge. The hole stays open until you reach or get just below the water table or waterline. Then what happens? It collapses.

Well the same goes for drilled shafts excavated below the water table or in unstable soils.

During the drilling of the hole, a slurry is introduced that “stabilizes” the sides of the hole and prevents the soils from collapsing into the hole.

Upon reaching the designed shaft tip elevation, the hole is cleaned, then the rebar cage placed.

Unlike the dry shaft method, the concrete is being placed “under the water” and therefore a tremie is lowered into the hole and the concrete placed through the tremie, which is carefully removed a little at a time to avoid “breaching” the concrete.

THE PROCESS

Performing wet shaft construction is generally more expensive and difficult than dry shaft construction. Key elements to quality wet shaft construction are:

- Experienced Contractor
- Proper maintenance of slurry
- Clean hole

4-16

The three items listed above account for the majority of all problems or bad drilled shaft installations.

Experienced Contractor- It all starts here. Many General Contractors want to “do it all” and really do not have the experience, expertise or equipment to properly install wet shafts. If an inexperienced Contractor happens to get the project, you the Inspector are in for a real headache. In fact, the Contractor’s inexperience leads to the next two items.

Proper Maintenance of Slurry- If the slurry is not maintained properly, (i.e., sand content, viscosity, pH, etc.), there will be problems with either the hole caving, being unable to clean the hole properly or displace the slurry during concrete placement.

Clean Hole- If the hole is not clean there is little chance of having a good quality shaft in the end. Sediment, cuttings and slurry can prevent the concrete from being placed and forming within the shaft in the manner the designer assumed.

THE PROCESS

There are two forms of “wet” shaft construction:

- Static Process
- Circulation Process

4-17

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There are two general processes for accomplishing wet-method construction. The first process is termed here the "static" process. It is by far the most common process in the United States. The second process is termed the "circulation" process. The primary difference in the two processes is that the cuttings are lifted by the drilling tool in the static method, but they are transported to the surface in the slurry in the circulation method. Circulation drilling has the advantage that the cuttings can be pumped in the slurry to a remote point before being removed from the slurry and spoiled. Some experts also contend that reverse circulation drilling, the most common form of circulation drilling, produces a cleaner borehole base than ordinary static drilling.

THE PROCESS

THE STATIC PROCESS

- **Drilled down to the piezometric level**
- **Slurry introduced**
- **Cuttings are lifted from the hole**

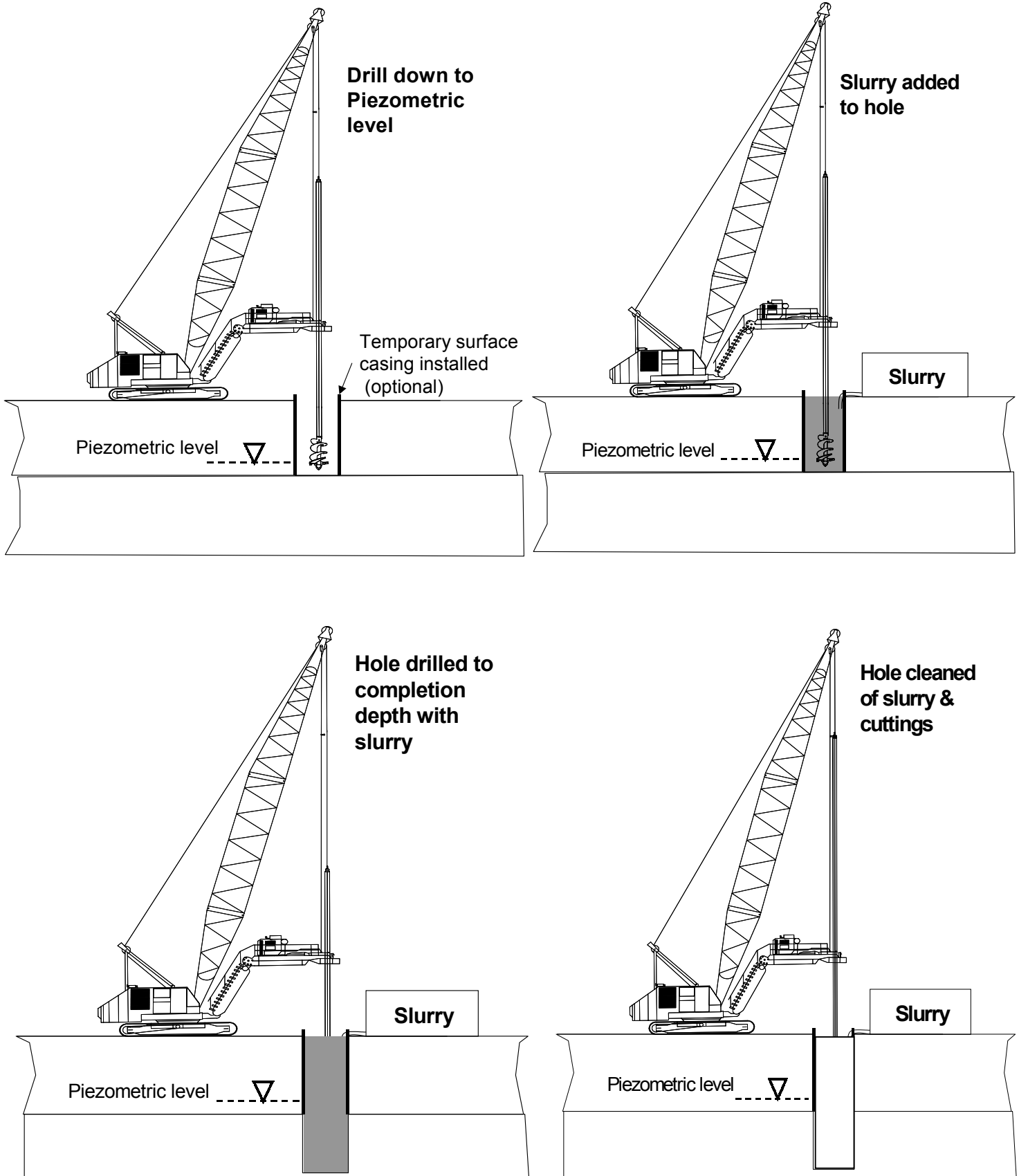
4-18

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The first step in the static construction process is to position the drilling equipment and to drill using the dry method until the piezometric surface is reached, the elevation of which has been determined during the subsurface investigation. At this point, slurry is introduced into the hole, as for the casing method, and drilling is continued. The excavation is carried to the full depth of the hole, with the slurry in place. During excavation, the top of the slurry column is always kept at an elevation above the piezometric surface. If the piezometric surface is at or above the ground surface (artesian or near-artesian conditions), a surface casing that protrudes above the ground surface to serve as a standpipe is necessary to keep the slurry head at its proper position. Maintaining head position in the slurry column is particularly important with polymer slurries.

Either mineral slurry (such as bentonite-based slurry) or polymer slurry can be employed in the static process. Mineral slurry is mixed such that some of the particles of granular soil being excavated are put and kept in suspension and are brought out of the hole when the slurry is flushed from the hole by placing the fluid concrete. Much of the soil being excavated, however, is lifted out with the drilling tool. Polymer slurries, on the other hand, have insufficient gel strength to hold sands in suspension (although silts may be held in suspension for a considerable time) so that all of the cuttings down to the size of fine sand must be lifted out with the drilling tool.

The Static Method



THE PROCESS

THE CIRCULATION PROCESS

- **Hole is drilled**
- **Slurry level maintained at the ground surface**
- **Cuttings and sand, is circulated to the surface, where it is cleaned and reintroduced down the hole.**

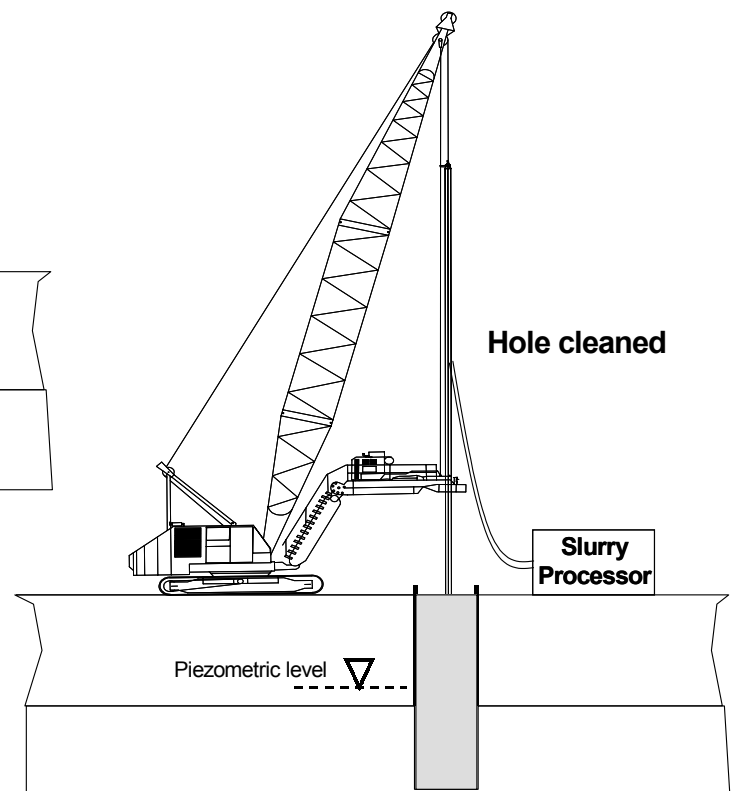
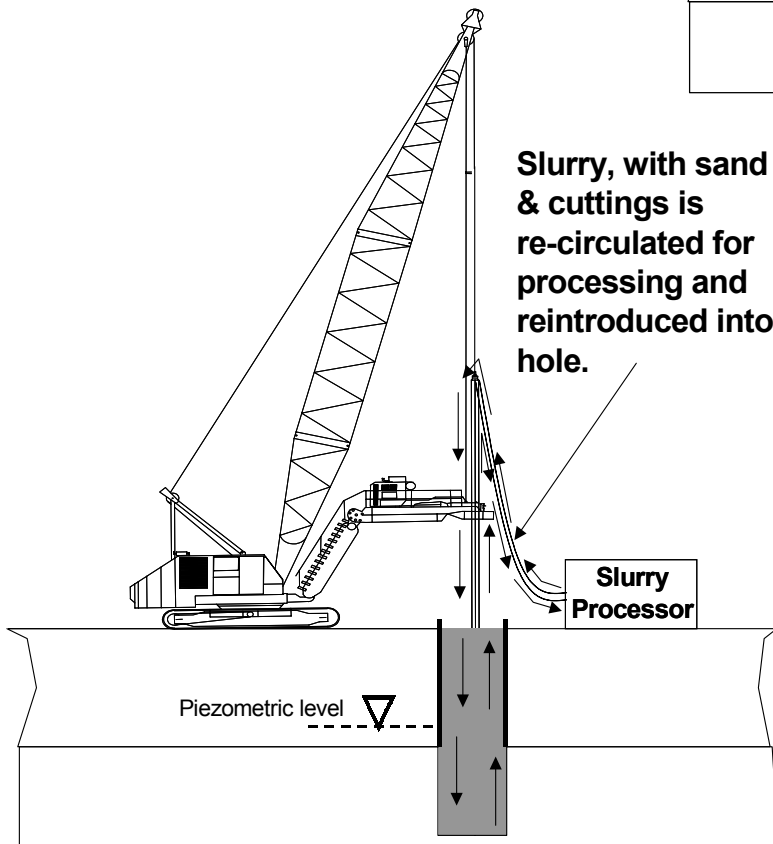
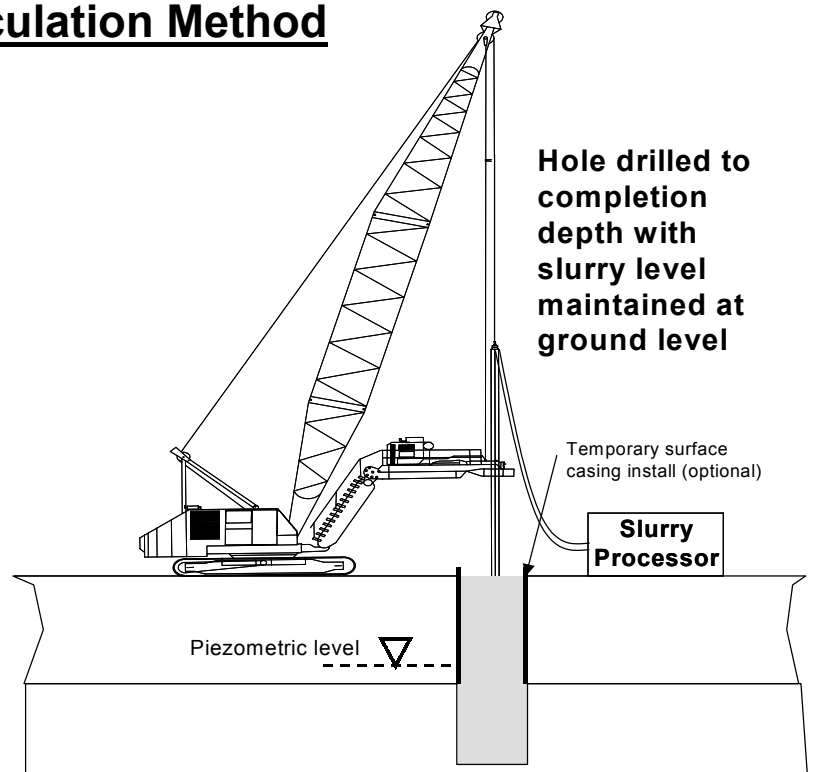
4-20

The circulation process is similar to the static process, except that only bentonite slurries are used, since other minerals and polymers are not capable of transporting solid cuttings effectively. The most common of the circulation processes, the "reverse circulation" process, is summarized here. It is also possible to drill using the "direct circulation process." The general differences in the two will be pointed out.

In reverse circulation drilling the drill rod (illustration next page) is a hollow pipe. The top of the pipe is connected to a flexible hose that is mated to a vacuum pump located on the ground surface. As the borehole is drilled, the cuttings at the bottom of the hole, directly under the drilling tool, are pushed to the center of the borehole by the special design of the drill and then sucked, along with the slurry, into an orifice at the bottom of the drill pipe and transported to the surface by the vacuum pump. After going through the pump the slurry/cuttings are pumped through another line to a cleaning plant, where the sand, silt and larger particles are removed. The clean slurry is then pumped back to the top of the borehole to be reused, resulting in a "closed loop" process. The slurry level is always maintained at the ground surface to allow the vacuum pump to lift the slurry and cuttings efficiently.



The Circulation Method





DRILL

4-22

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xxx.35.21 STANDARD EXCAVATION:

Standard excavation is excavation accomplished with conventional tools such as augers, drilling buckets, and overreaming (belling) buckets attached to drilling equipment of the size, power, torque, and down thrust (crowd) approved for use by the Engineer after successful construction of a trial drilled shaft.

The shaft hole is advanced. A temporary surface casing may be installed.



STABILIZE

Proper cleaning and maintaining of slurry is imperative.

FHWA Publication IF-99-025

xxx.38 SLURRY:

Mineral or polymer slurries shall be employed when slurry is used in the drilling process unless other drilling fluids are approved in writing by the Engineer....

A slurry is added to the hole to stabilize the sides and prevent caving.



The video shows a cleanout bucket being used to remove sediment from a drilled shaft hole.

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xxx.40 EXCAVATION INSPECTION:

....Final shaft depths shall be measured with a suitable weighted tape or other approved methods after final cleaning. Unless otherwise stated in the plans, a minimum of 50 per cent of the base of each shaft will have less than 1/2 inch (12.7 mm) of sediment at the time of placement of the concrete. The maximum depth of sediment or any debris at any place on the base of the shaft shall not exceed 1-1/2 inches (38 mm). Shaft cleanliness will be determined by the Engineer....

The shaft hole is cleaned to ensure excessive sediments, cuttings and water are removed from the hole.



POSITION

Proper cleaning and maintaining of slurry is imperative.

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xxx.50 REINFORCING STEEL CAGE CONSTRUCTION AND PLACEMENT:

The reinforcing steel cage, consisting of longitudinal bars, ties, cage stiffener bars, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement....

The reinforcing cage is positioned in the hole.



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xxx.60 CONCRETE PLACEMENT:

Concrete placement shall be performed in accordance with the applicable portions specifications on concrete materials in Section xxx.20 of this specification and with the requirements herein.

Concrete shall be placed as soon as possible after reinforcing steel placement. Concrete placement shall be continuous from the bottom to the top elevation of the shaft. Concrete placement shall continue after the shaft excavation is filled until good quality concrete is evident at the top of shaft....

The concrete is placed.

LEARNING OBJECTIVE # 2

Explain the wet shaft construction process.

What are the general steps in wet shaft construction?

What is perhaps the most important step in getting a good shaft with wet construction?

4-27

LEARNING OBJECTIVE # 2

Explain the wet shaft construction process.

What may be required at the surface to prevent caving?

What are the two types of wet shaft construction processes?

4-28



SLURRY

4-29

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xxx.38 SLURRY:

.....Mineral or polymer slurry shall be employed when slurry is used in the drilling process....

.....During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the hole. In the event of a sudden significant loss of slurry to the hole, the construction of that foundation shall be stopped until either a method to stop slurry loss or an alternate construction procedure has been approved by the Engineer...

....If approved by the Engineer, the Contractor may use only water as a drilling fluid....

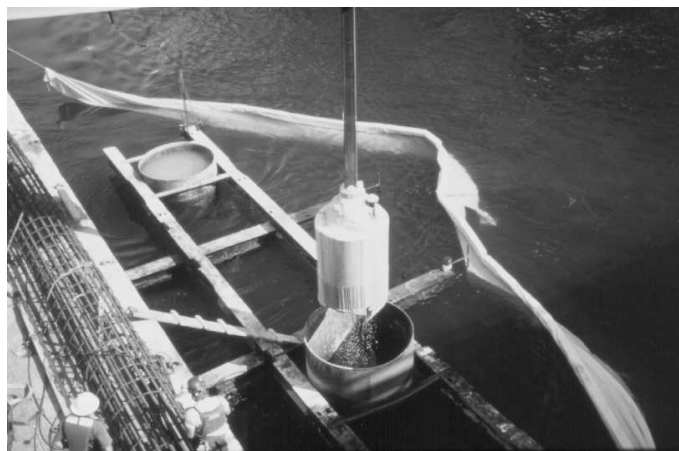
WHAT DOES THE SLURRY DO?

- **Maintains a Stable Borehole Prior to Concreting**
- **Maintains High Effective Stresses in the Soil While the Hole is Open (Retard Softening or Loosening)**
- **Facilitates Removal of Cuttings in “Circulation Drilling”**

4-30

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Drilling slurry is employed as a construction aid in two of the three general methods of drilled shaft construction (the casing method and the wet method), and there can be no doubt that slurry plays an important role in the construction of drilled shafts. When an excavation encounters soil that potentially may cave, filling of the excavation with drilling slurry, with the proper characteristics and at the proper time, will allow the excavation to be completed to full depth with little difficulty. The slurry must have the proper characteristics during the drilling operations and at the time the concrete is placed.



TYPES OF SLURRY

Mineral Slurry

- **Natural mineral clays**
- **Bentonite, attapulgite and sepiolite**
- **Bentonite is the most common**
- **Attapulgite and sepiolite are typically used in saltwater environments**
- **Must be hydrated**

4-31

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Bentonite slurries have been used commonly in drilled shaft construction in the United States since the 1960's. Other processed, powdered clay minerals, notably attapulgite and sepiolite, have been used on occasion in place of bentonite, usually in saline ground water conditions.

Bentonite and other clay minerals, when mixed with water in a proper manner, form suspensions of microscopic, plate-like solids within the water. This suspension, in essence, is the drilling slurry. If the fluid pressures within the slurry column in the borehole exceed the fluid ground water pressures in a permeable formation (e.g., a sand stratum), the slurry penetrates the formation and deposits the suspended clay plates on the surface of the borehole, in effect forming a membrane, or "mudcake" that assists in keeping the borehole stable.

In order for bentonite particles to break down into these separate plates, the mixing water must first hydrate the bentonite. Not until this process is completed will bentonite slurry be effective. The process requires both mixing effort (shearing) and time -- generally several hours. One of the cardinal rules of drilling with bentonite slurry is that all newly mixed bentonite must be allowed to be hydrated for several hours before final mixing and introduction into a borehole. Bentonite slurry should be added to the borehole only after its viscosity (resistance to flow, discussed later) stabilizes, which is an indication that the bentonite has become fully hydrated.

TYPES OF SLURRY

Polymers- are semi-synthetic or totally synthetic chemical slurries.



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Drilling slurries can also be made of mixtures of chemicals called polymers and potable water. Polymers have been used in preference to bentonite in well drilling for some time in Soil profiles that contain considerable clay or argillaceous (clay-based) rock, because bentonite slurries have a tendency to erode clayey rocks and to produce enlargements and subsequent instabilities in the boreholes. Polymer slurries have become popular in drilled shaft construction in all types of soil profiles because they require less conditioning before reuse than bentonite slurries and because they can be disposed of more inexpensively than bentonite slurries.

Take Care With Polymers

- **“Iffy” in Silt-Rich Soils**
- **40-Weight PHPA’s Seem to Perform Better than 30-Weight**
- **Different Products are Different Chemically**
- **Specific Polymer Products Should be Specified on a Site-Specific Basis**
- **Need to be Premixed**

4-33

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Polymer slurries have a mixed record in drilled shaft construction. Their chemistry is different from that of mineral slurries. The normal construction strategy with polymer slurry is to drill the hole under polymer and then let any suspended cuttings settle out before cleaning the hole and concreting. The time required for this to happen is almost impossible to predict, especially with silts, and for this reason alone, site-specific technique shafts with the proposed polymer product should be prescribed for jobs on which the contractor wishes to use a polymer slurry product. When suspended soil is still settling as the concrete is placed, it can accumulate on top of the column of concrete and become lodged in the rebar cage at an unknown depth, causing a defect. It is also important that polymers be kept out of contact with cement as much as possible during the construction process, since cement will cause the polymer to agglomerate. It is generally regarded at present to be good practice to use heavier weight (“40 weight”) polymers than lighter-weight polymers. It is also important that all polymers be premixed prior to placing the polymer in the borehole.

TYPES OF SLURRY

Blended

- a mixture of mineral and polymer slurry.

4-34

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xxx.38 SLURRY:

....If the Contractor proposes to use a blended mineral-polymer slurry, the Contractor shall submit a detailed report specific to the project prepared and signed by a qualified slurry consultant describing the slurry materials, the mix proportions, mixing methods and quality control methods.

SLURRY COMPARISONS

	Mineral Slurry	Polymer Slurry
Best Application	Cohesionless soils	Clays and argillaceous rock
Mixability	Difficult- must be hydrated for extended time	Easy
Mix Water Sensitivity	Saltwater sensitive	Yes/No
“Caking” Ability	Best	OK
Suspension Ability	Best	OK

4-35

OTHER DRILLING FLUID

Water

4-36

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xxx.38 SLURRY:

....If approved by the Engineer, the Contractor may use only water as a drilling fluid. In that case, all of the provisions in the table shown in this section for mineral slurries shall be met, except that the maximum density shall not exceed 70 pcf (11.0 kN/m³)....

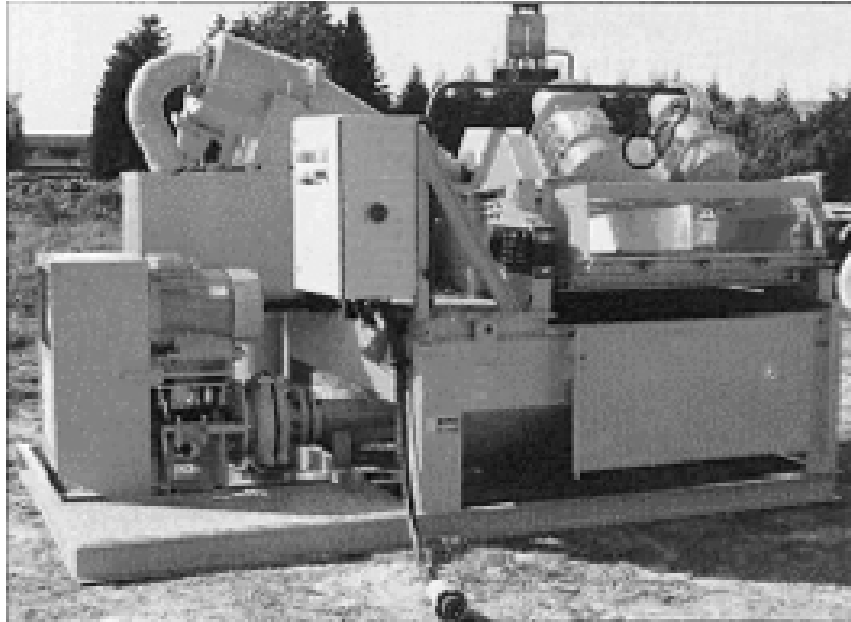
Table referred to from Chapter 15, Page 444.

SLURRY TESTING - BENTONITE/ATTAPULGITE			
Item to be measured	Range of Values @ Time of Slurry Introduction	Range of Values @ Time of Concreting	Test Method
Density	63.4* - 69.1* pcf 10.1* - 10.8* kN/m ³	64.3* - 75.0* pcf 10.1* - 11.8* kN/m ³	Mud density balance API-13B-1; Section 1
Viscosity	28 to 45 sec/quart**	28 to 45 sec/quart**	Marsh Cone Method API-13B-1; Section 2.2
pH	8 - 11	8 - 11	Electric pH meter or pH indicator paper strips
Sand Content	4% or less	4% or less***	API-13B-1

***Increase by 2 pcf (0.31 kN/m³) in salt water**

**** Standard measurements are in seconds per quart**

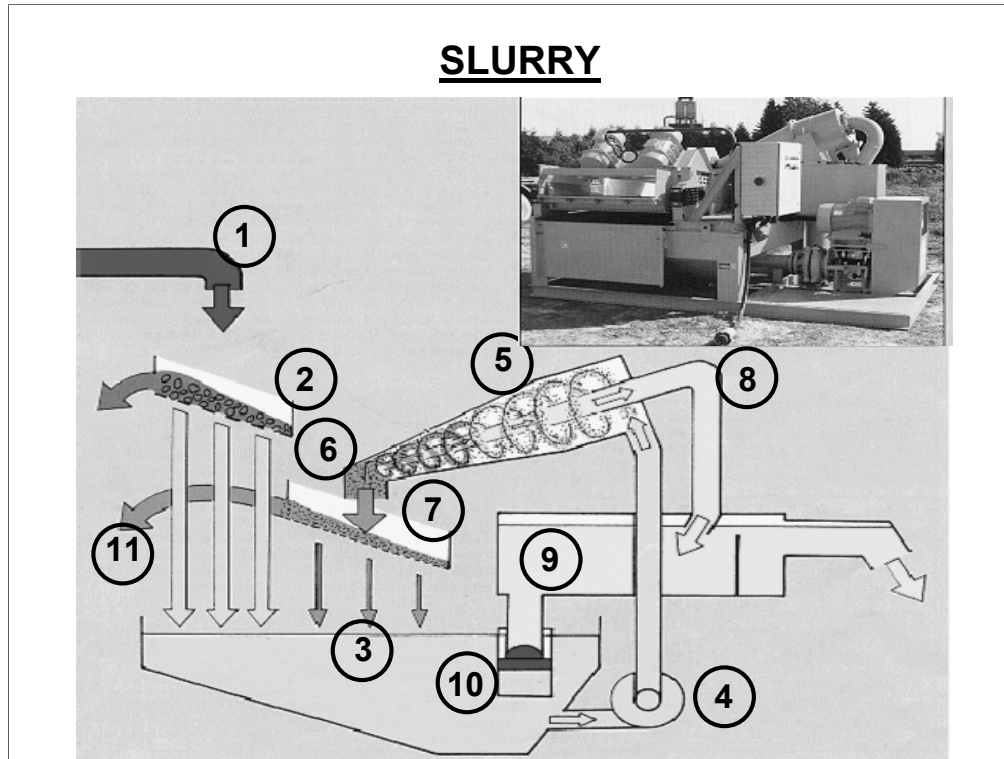
***** 1% at base of drilled shaft excavation for polymer slurries**

DESANDER

4-37

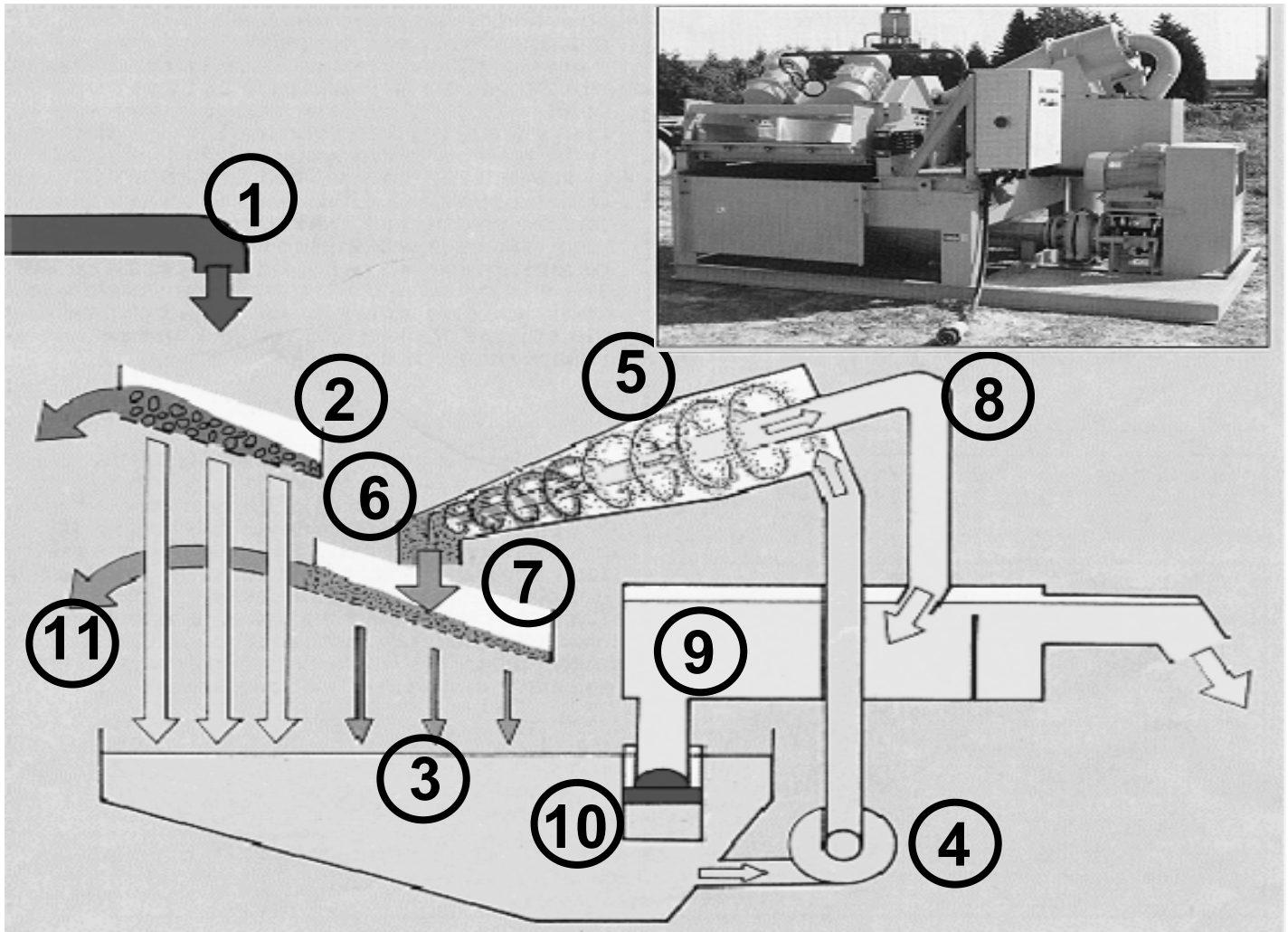
FHWA Publication IF-99-025**xxx.38 SLURRY:**

.... Desanding equipment shall be provided by the Contractor necessary to control slurry sand content to less than 4 percent by volume at any point in the borehole at the time the slurry is introduced, including situations in which temporary casing will be used. Desanding will not be required for sign post or lighting mast foundations unless shown in the plans or special provisions...

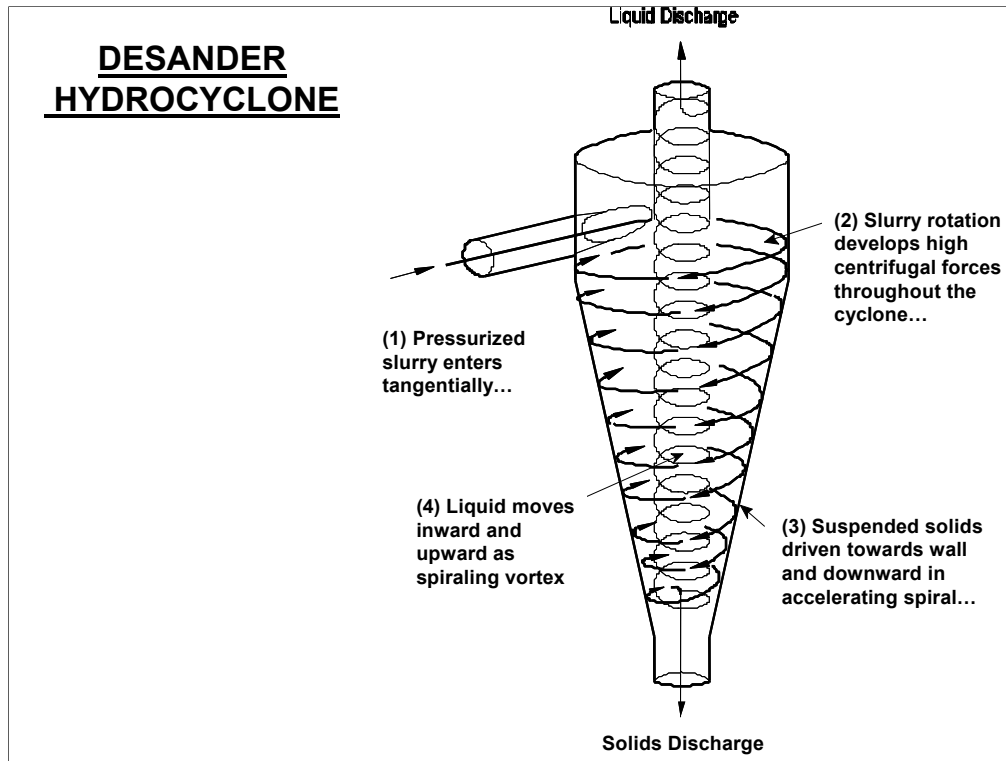


The charged slurry passes from the hopper **(1)** to a scalping vibrating screen **(2)**, which removed fractions $7\frac{1}{4}$ inch ($>5\text{mm}$) and from there to a storage reservoir **(3)**. A circulating pump **(4)** pumps it into the cyclone **(5)**, which separates the fines from the slurry. Fine particles are discharged via the cyclone underflow **(6)** and drop onto vibrating dewatering screen **(7)**, which separates out any fines still remaining in the slurry. The treated slurry is discharged into a holding tank **(9)** via the cyclone overflow **(8)**, then to a separate outside storage tank. An automatic level control **(10)**, operated by a float, keeps the slurry level in the storage reservoir constant during the desanding process. The sand is then discharged from the unit **(11)**.

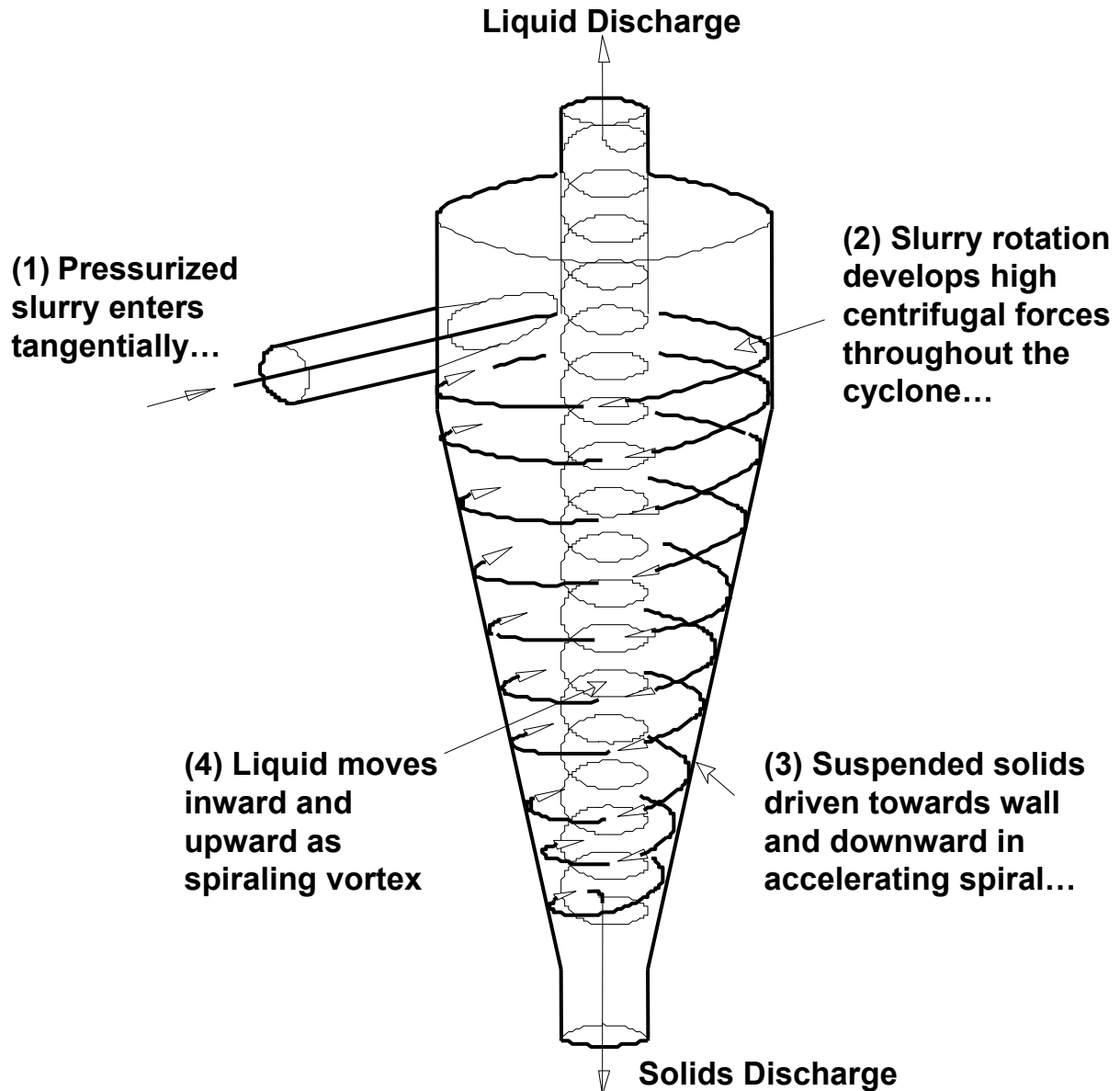
PRINCIPLES OF DESANDING UNIT



The charged slurry passes from the hopper (1) to a scalping vibrating screen (2) which removed fractions $7\frac{1}{4}$ inch ($>5\text{mm}$) and from there to a storage reservoir (3). A circulating pump (4) pumps it into the cyclone (5) which separates the fines from the slurry. Fine particles are discharged via the cyclone underflow (6) and drop onto vibrating dewatering screen (7), which separates out any fines still remaining in the slurry. The treated slurry is discharged into a holding tank (9) via the cyclone overflow (8), then to a separate outside storage tank. An automatic level control (10), operated by a float, keeps the slurry level in the storage reservoir constant during the desanding process. The sand is then discharged from the unit (11).



DESANDER HYDROCYCLONE



This figure shows the principles on how a hydrocyclone works. The slurry is pumped from the shaft and enters the hydrocyclone tangentially under pressure. The slurry rotation develops high centrifugal forces throughout the cyclone. The suspended solids are driven outward towards the wall and downward due to the shape of the hydrocyclone. As they move downward they increase in acceleration while at the same time liquid moves inward and upward as a spiraling vortex. Solids are discharged out of the bottom of the cone, liquid is discharged at the top. Along with mud testing technologies, desanding units are for the most part, a product of the oil drilling industry. Consequently there are a number of manufacturers in the United States producing for various needs including the oil industry, slurry wall construction and for drilled shaft contractors. Some contractors have assembled their own components and created their own designs. As an inspector therefore, you are apt to see a number of different configurations and brand names. Efficiencies are likely to vary depending on how well the units are designed for the specific materials being excavated.

MANAGING SLURRY FOR BOREHOLE STABILITY

- **Proper Dosage and Solids Content for Proper Flowability and Cake Properties**
- **Thorough Mixing / Adequate Time for Hydration (Bentonite / Polymers)**
- **Maintenance of Head in Borehole**
- **Maintenance of pH, Hardness, Salts**
- **Minimize Pressures from Tools**

4-42

This slide is the first of three that should be considered a checklist for proper slurry construction. Discuss each point briefly in turn. Be sure to mention that all slurries hydrate water, including polymers. This means that they should be mixed in tanks and held for an appropriate time before introduction in a borehole. Mixing should only be with fresh, potable water, which is buffered with a manufacturer-acceptable compound to raise its pH to a range acceptable to the manufacturer of the product before the slurry stock is added. This is especially important with polymers. Head should always be maintained well above the piezometric surface, as mentioned earlier. This is especially critical for polymer slurries, which are lightweight compared to mineral slurries.

RANGES OF SLURRY PROPERTIES (FINE SANDS)

<i>Property</i>	<i>Bentonite</i>	<i>PHPA Polymer</i>
<i>Marsh Funnel (sec / quart)</i>	<i>28 - 45</i>	<i>33-45**</i>
<i>Unit weight (lb/ cu ft)</i>	<i>64 - 69*</i>	<i>62 - 63</i>
<i>pH</i>	<i>8 - 11</i>	<i>8 - 11**</i>
<i>Sand Content</i>	<i>< 4 %*</i>	<i>< 1 %</i>
<i>Hardness</i>	<i>N/A</i>	<i>< 50 ppm as Ca++</i>
<i>*Before introduction into borehole. Up to 75 pcf or 10% sand permitted before concreting.</i>		
<i>** Higher for vinyls.</i>		

4-43

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These are typical desirable slurry properties. Those shown for polymer slurries are not industry consensus values, but merely guidelines. For example, higher viscosities are acceptable with some products, especially in silt-rich soils (to keep the silt in suspension). Some suppliers require slightly different pH ranges for optimum performance. So, consider this only as a general guideline. In actual practice, the manufacturer's guidelines for polymers should be followed, but they should be proved for the project at hand through the construction of one or more technique shafts on the project site.

CONTROLLING SLURRY

Control tests are used to maintain proper slurry condition. Tests are conducted for:

- Density- the slurry weight
- Viscosity- flow: consistency
- pH- acidity: alkalinity
- Sand Content

4-44

FHWA Publication IF-99-025

Mineral and polymer slurries will have certain desirable characteristics when being used to facilitate excavation. Therefore, certain key properties must be measured to ensure that these characteristics are operative. Testing will be desirable just before the slurry is introduced into the borehole, perhaps on occasion as drilling progresses, and **always before concrete is placed**.

For blended slurry, the tests and criteria are the same as for mineral slurry. Some of the tests would normally be used only for designing slurry mixes or for troubleshooting during construction. For most jobs, the mud balance for density, the Marsh funnel or rheometer (preferred) for viscosity, and a pocket pH meter or pH paper are adequate to monitor the properties of the slurry during routine construction operations.

HISTORY OF PROBLEMS WITH SLURRY

SLURRY TYPES	PREPARATION	PROBLEMATIC RATING
Bagged Commercial Bentonite	Properly Mixed and Hydrated	Fewest
Polymer Slurries	Premixed (2 - 4 hours for hydration)	Some
Polymer Slurries	Mixed in hole	Numerous (Not Recommended)
Water Mixed with Natural Soil	—	Most (Not Recommended)

4-45

This slide indicates that the history of drilled shaft construction on FHWA projects has indicated that defects occur in drilled shafts constructed with various types of slurry at different frequencies. This slide indicates the order, with the slurry producing the fewest defects first. Although there is relatively little information on blended slurries, these appear also to have some of the same problems as polymer slurries and should be treated in a like manner (insist on technique shafts with careful inspection of the concrete near the top of the shaft) until more is known.

LEARNING OBJECTIVE # 3

Describe and identify mineral and polymer slurry and other drilling fluids.

What are the 2 main types of slurries?

What purpose does the slurry serve?

4-46

LEARNING OBJECTIVE # 3

Describe and identify mineral and polymer slurry and other drilling fluids.

If desanding is required, the sand content of mineral slurry is to be no greater than what %?

What common control tests are performed on slurry?

4-47

TYPICAL PROBLEMS

- **Inexperienced Contractor**
- **Dirty Hole**
- **Improper Slurry Control**

4-48

Inexperienced Contractor

- **Doesn't understand the mechanics of what is happening**
- **Underestimates the need for slurry**
- **Uses improper slurry for conditions**
- **Fails to properly use & control slurry**
- **Doesn't adequately clean the hole**

= Many Problems

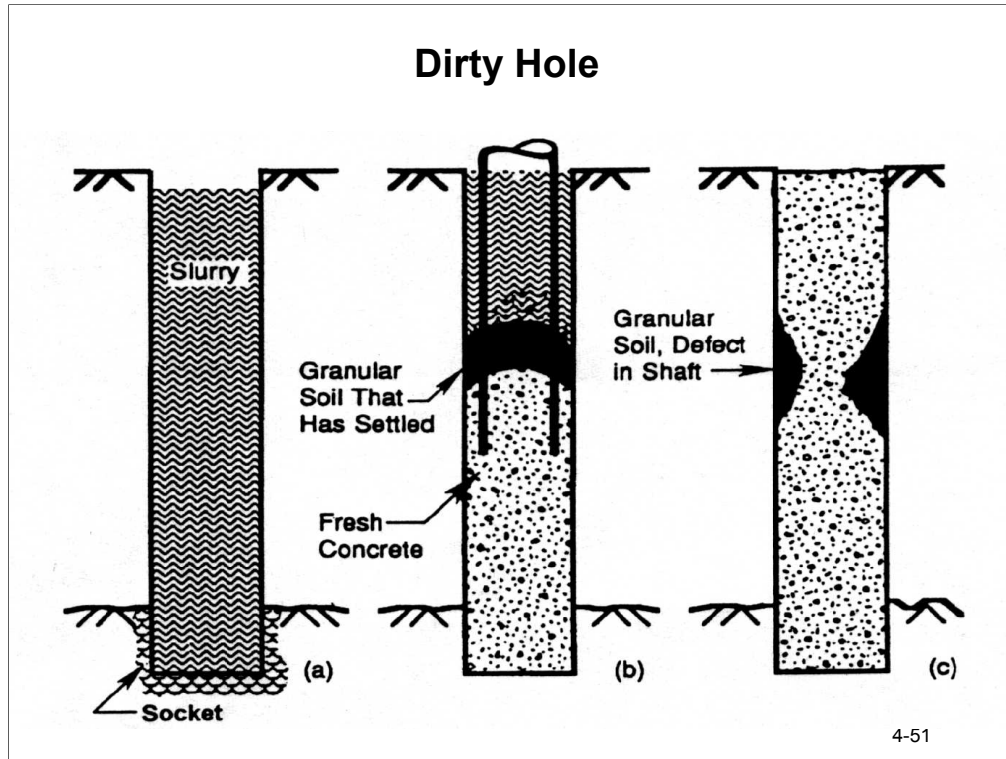
4-49

Dirty Hole

- **Leaves cuttings and sediment which prevents good placement of concrete**
- **Creates voids in the shaft concrete**
- **Impacts shaft functionality**

4-50

One of the most common problems is improperly controlled slurry, which has more sediment in it that it can hold in suspension. If not properly sampled and tested, goes un-noticed and therefore it settles out.



Improper Slurry Control

- **Fails to properly suspend and facilitate the removal of sediments and cuttings**
- **Does not control caving**
- **Does not control swelling of soils**
- **Hinders slurry displacement during concrete placement**
- **Leads to a dirty hole**

4-52

**Poor Slurry Job****Excellent Slurry Job**

4-53

FHWA Publication IF-99-025

The shaft on the left was constructed in an uncontrolled bentonite slurry whose unit weight was about 100 pcf and sand content was above 20 percent. Note the exposed rebar at the bottom (trapped sediment) and the exposed rebar about 1/3 of the way down from the top. This coincided with the level of the water table. Apparently, as the sediments being pushed up by the concrete column lost buoyancy at this level the concrete column broke through, trapping the sediments there.

The shaft on the right was constructed using bentonite slurry whose properties fell within the ranges recommended here. No defects and no malformations. We should expect to produce shafts like this if specifications are written properly, inspection is competent and contractors are qualified.

LEARNING OBJECTIVE # 4

Describe typical construction problems associated with wet shafts.

What are the 3 main problems associated with wet shaft construction?

What is often underestimated by the inexperienced Contractor?

4-54

LEARNING OBJECTIVE # 4

**Describe typical construction problems
associated with wet shafts.**

Improper control of slurry can lead to ____?

4-55

LEARNING OBJECTIVES

- **Recognize the difference between dry and wet shaft construction.**
- **Describe the wet shaft construction process.**
- **Describe and identify mineral and polymer slurry and other drilling fluids.**
- **Describe typical construction problems associated with wet shafts.**

4-56



Any questions in mind? Ask them.

NOTES

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